

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Amendment of the Commission's Rules with	)	GN Docket No. 12-354
Regard to Commercial Operations in the 3550-	)	
3650 MHz Band	)	

Comments of

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We are professors in the Electrical Engineering and Computer Science Department at the Massachusetts Institute of Technology (MIT) and co-directors of the newly launched MIT Center for Wireless Networks and Mobile Computing (known as [Wireless@MIT](http://wireless.csail.mit.edu)) in the Computer Science and Artificial Intelligence Laboratory (CSAIL), MIT's largest research lab. Wireless@MIT brings together academic and industry researchers from across the wireless ecosystem to develop cross-layer innovations in mobile system design, focusing on improvements to spectrum efficiency, power consumption, application performance, and security and privacy.

As academics engaged in the research and development of wireless technologies, we submit these comments to express our strong support for the FCC's efforts in the 3.5GHz proceeding,<sup>2</sup> which we believe promotes the important and worthwhile goal of *facilitating the movement of innovations from research labs to the marketplace*. While the improvements that the FCC recently adopted to its experimental licensing rules<sup>3</sup> will

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<sup>1</sup> William H. Lehr, Research Associate at CSAIL, assisted with the drafting of these comments. The views expressed herein are those of the authors and do not represent the views of MIT, CSAIL, or other participants in Wireless@MIT (<http://wireless.csail.mit.edu>).

<sup>2</sup> *In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Notice of Proposed Rulemaking and Order, December 12, 2012.

<sup>3</sup> *In the Matter of Promoting Expanded Opportunities for Radio Experimentation and Market Trials under Part 5 of the Commission's Rules and Streamlining Other Related Rules*, ET Docket

help researchers to test their innovations more efficiently, this proceeding is a necessary further step towards motivating the adoption of successful innovations in operational wireless networks.

Within Wireless@MIT and similar academic and industry research labs across the country, engineers and scientists are developing a wide range of technologies that can expand the capabilities, performance, and capacity of wireless networks and applications – but only if spectrum policies evolve to make it possible to deploy such innovations at scale, and to ensure that sufficient spectrum is available to support continued growth in business and consumer adoption of wireless devices and applications.

The FCC's proposals for sharing spectrum in the 3.5GHz band helps further these objectives by:

1. *Expanding spectrum sharing options* for commercial and government users, thereby *alleviating spectrum scarcity* which poses a serious threat for the continued growth of wireless services, and hence, the engine that helps drive the entire innovation process.

Previous efforts by the FCC to complement additional spectrum licenses with a range of spectrum management models beyond exclusive licensing have had positive industry, economic and societal impacts. The adoption of Part 15 unlicensed rules enabled the development of innovations from baby monitors to Bluetooth hands-free electronics in cars to WiFi in homes and business – including WiFi's use for cellular network offload. The lightly-licensed approach in the 3650-3700 band helped foster the provision of rural broadband access by Wireless Internet Service Providers (WISPs). Most recently, the FCC's adoption of rules for dynamic access to the TV white spaces has helped stimulate the development of standards and equipment to operate successfully within that framework. This proceeding builds on these earlier efforts and will continue the progress of creating value by expanding sharing options into new bands and new contexts.

2. *Focusing on enabling small cell systems*, which is doubly important: first, because small cells facilitate spatial reuse which reduces spectrum scarcity problems; and second, because much of the focus of wireless innovation in recent years, and especially those that relate to spectrum sharing, find their best application in low power, small cell systems.

For example, innovative technologies for interference management, like MegaMIMO (also known as Joint Multi-user Beamforming)<sup>4</sup> and interference

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No. 10-236, Report and Order, January 31, 2013.

<sup>4</sup> See Hariharan R., S. Kumar, and D. Katabi, "JMB: Scaling Wireless Capacity with User Demands," ACM SIGCOMM, 2012, attached to these comments and also available at

alignment, address cell edge interference issues, which are of particular importance for small cells.

3. *Moving expeditiously in targeting the 3.5GHz band* that the NTIA (Oct2010) identified as a "fast track" candidate for spectrum sharing. There are 150MHz of underutilized spectrum in this band that is currently dedicated for use by Naval radar systems and Fixed Satellite System (FSS) earth stations that earlier studies have concluded cannot be cleared from the band economically. Making this band available for commercial users requires adoption of new techniques for enabling dynamic sharing with incumbent systems. Focusing on this band at this time is the right choice: it can motivate technology transfer from pent-up laboratory research to full-scale practice, and can set the stage for regulatory innovation in governance models for shared spectrum going forward, supporting a diverse range of application and stakeholder needs.

The FCC's efforts in this proceeding help to create a market for wireless innovations that improve device and network performance and expand application capabilities. In so doing, they help drive the demand for spectrum that makes sharing underutilized spectrum more intensively a necessity, as well as for the wireless innovations that make it feasible to share spectrum efficiently.

4. *Promoting progress towards a more flexible and evolvable spectrum management framework.* By proposing a dynamic database that gathers information about spectrum usage, this NPRM lays the groundwork for adapting spectrum regulation more quickly to provide spectrum usage rights that support the best sharing technologies for today's *and* tomorrow's wireless innovations.

The 3.5GHz proposal builds on the TVWS approach of using a dynamic database as part of an evolving Spectrum Access System (SAS). The SAS makes it feasible to manage spectrum usage rights more flexibly over different geographies and at multiple time scales – from the increasingly shorter time scale anticipated by new dynamic spectrum access technologies to the longer time scales of regulatory proceedings. The SAS may be enhanced and complemented by other evolving spectrum sharing technologies, such as sensing and more agile wideband radios that are under development.<sup>5</sup>

In summary, the scarcity of wholly reallocable spectrum means that the FCC is focusing appropriately on expanding options for more nuanced spectrum management techniques beyond the extremes of exclusive-use licensing and low-power unlicensed use. Furthermore, the FCC's proposals in this proceeding have the potential to develop a

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<http://groups.csail.mit.edu/netmit/wordpress/wp-content/themes/netmit/papers/megamimo-sigcomm2012.pdf>

<sup>5</sup> See Hassanieh, H., L. Shi, O. Abari, E. Hamed, and D. Katabi (2013), "GHz-Wide Sensing and Decoding on Commodity Radios," Massachusetts Institute of Technology, attached to these comments.

management framework that can adapt at a faster clock speed that more closely approximates the pace of wireless innovation and the evolution of commercial markets. We appreciate and support the FCC's proposal to move forward on these issues that are so important to continued innovation in wireless broadband and other wireless applications.